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Soviet RYAD Computer: A Program in Trouble

Confidential
ER 77-10491
September 1977

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Approved For Release 2001/03/22 : CIA-RDP79B00457A000700100001-5

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Soviet RYAD Computers: A Program in Trouble

Central Intelligence Agency
Directorate of Intelligence

September 1977

Key Judgments

The USSR continues to experience serious delays in the development, production, installation, and effective use of its RYAD computers, which form the cutting edge of the Kremlin's computer modernization program.

In the Ninth Five-Year Plan, 1971-75, the USSR and its East European allies produced only 10-15 percent of the anticipated number of RYAD computers, a series of third generation computers modeled on the IBM-360 series. Furthermore, output has included only the smaller, less powerful RYAD models, with the final product decidedly inferior to the IBM originals in reliability and compatibility and in the quality of associated input-output and auxiliary storage devices. Despite this poor track record, the Kremlin is pressing ahead in the Tenth Five-Year Plan period, 1976-80, with the development of a RYAD II series—similar to the IBM-370 series.

In addition to the general-purpose RYAD computers—which represent about 20 percent of the current value of output of the Soviet computer industry—the USSR is turning out several types of specialized military and civilian computers. Through the brute force application of large technical resources the USSR is gradually incorporating modern computer technology into its military and industrial operations, but at an efficiency level far below Western standards and at a technological level roughly 10 years behind. Use of RYAD computers to handle complex Soviet military problems, such as command and control, will be delayed until larger RYAD systems, equipped with high-performance, off-the-shelf peripherals, appear in the 1980s.

While the use of computers in specific civilian sectors moves forward in numerous small ways, the difficulties encountered in these relatively simple

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tasks demonstrate the unreality of grandiose schemes for computerizing the planning, management, and operation of the entire economy.

Soviet and East European achievements in the computer field would be even less impressive were it not for substantial acquisition—legally and illegally[1]—of Western equipment and technology.

[1] The term *illegal* in this report refers to acquisition in contravention to established COCOM barriers.

Soviet RYAD Computers: A Program in Trouble

Origin of the RYAD Series

The Soviet decision in the mid-1960s to build a family of compatible[2] RYAD computers was a belated response to the need for complete modernization of Soviet computer technology. The USSR was lagging far behind the West in the development, production, and application of data processing systems for economic and industrial uses. Soviet computers had been designed mainly for scientific applications and had insufficient internal memories. Auxiliary memory and input-output equipment were technically poor and in short supply, electronic components were unreliable, spare parts were difficult to obtain, and a multiplicity of models prevented users from sharing programs and experiences. Moreover, because individual users typically made nonstandard modifications, even compatibility between computers of the same model was lost.

To cut development time and save resources, top-level planners chose to adopt the IBM series 360 logic design and software, using the engineering talents and production capacity of Soviet and East European countries. The planners may also have gambled that the improvement in relations among several East and West European countries would speed acquisition of needed Western know-how. Also, the Soviets wanted to decrease East European reliance on the West as a supplier of computing equipment.

The RYAD program was designed as a family of seven computer models[3] which were to be compatible with each other and with IBM-360 computers as well. Production, originally planned to begin in 1970, was delayed until late 1972 when serial production started on the two smallest models in the series, the ES-1020 and ES-1030. In May 1973, several different RYAD central processing units and a number of RYAD-compatible peripheral equipments were exhibited in Moscow. Production of third generation RYADs thus began in the USSR and Eastern Europe about three years later than anticipated and nearly 10 years later than production of comparable equipment in the West.[4]

Levels of Output

The RYAD production program has contributed to the advancement of the Soviet position in computers, although at a pace far below expectations. The USSR and Eastern Europe together produced an estimated 1,700 RYADs during the Ninth Five-Year Plan period 1971-75.[5] The USSR produced about 80 percent of this total—mostly the smaller ES-1020 and ES-1030 models (see table 1). The largest RYAD models, the ES-1050 and ES-1060, which the Soviets had hoped to put into quantity production, were still under development in 1975.

Output of RYADs in the USSR rose sharply over the plan period, from only 10 units in 1971 to 700 units in 1975. This growth was achieved mainly by shifting resources from the production of MINSK-32s to RYADs (ES-1020) at the Minsk Computer Plant, and from M-222s to

[2] Two computer models are compatible when the same programs can be used on each.

[3] RYAD models are referred to by the designation ES (*Edinnaya Sistema*—Unified System) followed by four digits or by R (RYAD) followed by the final two digits (e.g., ES-1010 is equated to R-10). The seven models were the ES-1010, 1020, 1021, 1030, 1040, 1050, and 1060.

[4] For additional information on the early phases of the RYAD program see: ER RP 73-15, *Soviet RYAD Computer Program*, August 1973 (SECRET NOFORN). This report furnishes details on the performance characteristics of the various RYAD models.

[5] For the methodology used in production estimates, see the Appendix.

Table 1

USSR and Eastern Europe: Estimated Production of RYAD Computers

	Model	1971	1972	1973	1974	1975	1971-75
Total		**10**	**40**	**206**	**559**	**886**	**1,701**
Total production		10	39	205	555	880	1,689
USSR		10	35	175	450	700	1,370
	1020	5	20	100	300	400	825
	1030	5	15	75	150	300	545
Eastern Europe		0	4	30	105	180	319
Bulgaria	1020	0	0	5	10	10	25
Czechoslovakia	1021	0	2	5	15	20	42
East Germany	1040	0	2	10	30	50	92
Hungary	1010	0	0	10	50	100	160
Total prototype		0	1	1	4	6	12
USSR		0	0	1	4	6	11
	1050	0	0	1	4	5	10
	1060	0	0	0	0	1	1
Eastern Europe		0	1	0	0	0	1
Poland	1030	0	1	0	0	0	1

RYADs (ES-1030) at Kazan. By the end of 1975, production of MINSK-32s had been phased out entirely. This left RYAD as the only major computer system in production that was intended mainly for use in economic data processing.[6]

As for East European producers, East Germany provided the only success story. East Germany developed and produced the ES-1040, a well-made and apparently reliable machine. Although output remained small, by the end of 1975 East Germany was producing at the rate of about 100 units per year and had the manufacturing facilities to produce roughly twice that figure. Elsewhere in Eastern Europe, progress in the production of RYADs was slow. Hungary took on the smallest and simplest machine in the RYAD family, the ES-1010, but had gotten production up to only 100 units by 1975. Czechoslovakia was producing the ES-1021 at the rate of less than two per month in 1975, and Poland, which was intended to be a major producer of the ES-1030, had built only a single prototype.

Furthermore, in Hungary and Czechoslovakia, the machines produced were not fully compatible with the other RYAD models. They are still included in the RYAD family because they can use the same input-output and related peripheral equipment. The ES-1010 is used as (a) a "front end processor," initially massaging the data for further processing by the larger RYADs, (b) a control unit in a process control environment, or (c) a minicomputer for standalone problem solving. The Czechoslovak machine has found little acceptance either inside or outside Czechoslovakia.

Failure to Meet Plan

Output of RYADs in the USSR and Eastern Europe has fallen far short of the planners'

[6] In addition to RYAD, the USSR is producing a series of computers for industrial control applications. Some models in this series, such as the M-4030, also are based on IBM-360 designs and are competitive with RYADs for general data processing applications. The status of production of a third series, the URAL computers, which had resulted from earlier Soviet attempts to provide a compatible family of computers for general uses, is not known.

expectations. Specific numerical goals for the production of RYADs have never been published. The Soviets, at least early in the program, apparently anticipated output of 3,000 to 5,000 RYADs a year by 1973. For instance, M.Ye. Rakovskiy, the Deputy Minister of GOSPLAN, hinted in 1971 that 12,000 to 15,000 RYADs would be available for use during the Ninth Five-Year Plan.

In the USSR, production of RYADs has been delayed by shortages of adequate components (mainly integrated circuits) and by backward production technology and quality assurance. Through 1973, few integrated circuits (ICs) were available for RYADs. The USSR produced ICs of the type used by smaller RYADs[7] only in very small quantities; yields of acceptable devices were low, with military authorities having first selection of the better quality devices. Output of ICs increased rapidly after 1973, enabling the USSR to move into commercial-scale production of the smaller RYAD machines.

Poor fabrication techniques have also held down production. Lacking the advanced machinery of Western producers, the Soviets have substituted manual techniques for automatic wiring of back panels and for automatic insertion of components into printed-circuit boards.[8] In addition, the Soviets have relied on simple electrical and electronic instrumentation (such as voltmeters and oscilloscopes) for online testing of subassemblies, while most Western producers use computerized test equipment.

Mass production of RYADs has also been delayed by tight competition for resources within the computer industry. RYAD, while the most publicized program, is only one of several large computer production programs in the USSR. The share of RYAD output in the total value of Soviet computer production probably amounted to less than 20 percent in 1975. This calculation is based on the unit price of RYAD 1020s and 1030s in standard configuration, i.e., including associated peripherals.

By 1980, RYAD production will remain less than half of the computer industry's output even in the unlikely event that RYAD production can be boosted to 3,000 units per year. That level of output would require commissioning new plant capacity or converting existing facilities to the RYAD program. In mid-1977 there was no evidence of either development.

Problems with Peripherals

Conventional types of peripheral equipment—punch-card and paper tape devices, line printers, and magnetic tape units—appear to be produced in adequate quantities to meet RYAD production needs, but are obsolescent by Western standards. For example, Soviet-produced line printers in use with RYADs are slower and of generally lower performance than printers in use with IBM Series 360 machines. Soviet magnetic tape units are approximately 10 years behind Western state of the art and have not been supplied with sufficient quantities of domestically produced high-quality magnetic tapes. The USSR has tried to remedy this shortage by importing tape from the US and Western Europe, and magnetic tape units from Eastern Europe.

Failure of the USSR to produce high-capacity magnetic disc drives and disc packs has been a major deficiency in peripherals technology. Most of the RYADs produced to date use low-capacity (7.25 megabyte)[9] disc drives produced by Bulgaria or 30-megabyte disc drives imported from the West. Soviet and Bulgarian claims that production of 100-megabyte drives is imminent are exaggerated, to judge from the continued vigorous pursuit of Western manufacturing technology for high-capacity drives.

Relation of RYAD to Overall Computer Effort

Despite the unspectacular performance during 1971-75, the Soviets appear committed to RYAD as the major computer system for meeting Soviet general-purpose data processing

[7] TTL (Transistor-Transistor Logic) of relatively low density (up to ten gates) and low power.

[8] Despite Soviet claims to have introduced automatic production and test equipment, Western observers have reported that computer production remains highly manual.

[9] Millions of bytes, each of which has eight binary digits.

Table 2

USSR: Estimated Value of RYAD Production as a Percent of Total Computer Production

	1971	1972	1973	1974	1975	Total
	Million 1967 Rubles					
Total computers	905	1,213	1,699	2,221	2,927	8,965
Of which:						
RYAD	8	25	122	296	486	937
ES-1020	3	11	53	158	210	435
ES-1030	5	14	69	138	276	502
	Percent					
RYAD as a share of total	1	2	7	13	17	10

needs. Conversion to large-scale production of upgraded models is now being accomplished and planning is under way for a follow-on program of more advanced RYAD-II systems.

At the same time, other special-purpose computer programs for both military and industrial applications are proceeding apace. Military programs include: development of a new military computer system at the Vilnyus Computing Machines Plant; expansion of military computer production at the Minsk Computer Plant; and continuing strong efforts on military-related computers by major development centers in Moscow, supported by production facilities in Moscow and Zagorsk. Among special-purpose computers for industrial applications, production of the M-6000 process-control minicomputer, believed to be a copy of a Hewlett-Packard model, is being emphasized.

Role of Western Technology

Western technology has made important contributions to the RYAD program, both directly and indirectly. The West has (a) been the source of designs for most models of the RYAD family, (b) provided manufacturing technology for disc drives and packs, and (c) furnished components, especially some types of integrated circuits in critically short supply in the USSR and Eastern Europe. Moreover, the USSR has acquired, through both legal and illegal channels, specific items of machinery crucial to the development of supporting technologies, such as machines used in the production of multilayer printed-circuit boards, integrated circuits, and memory cores. The Communist countries are acquiring valuable expertise in systems analysis, programing, and other computer specialties at a training center in Czechoslovakia established under United Nations auspices. Center specialists also conduct courses in the USSR and elsewhere in Eastern Europe. Much of this training and experience is applicable to the exploitation of RYADs. Finally, the Soviets have gained experience and training in systems analysis, software, and applications, through work in Western computer installations, and through purchases of RYAD-like computer systems.

The USSR began to copy IBM designs after it clandestinely acquired an unknown number of IBM-360 computers in the mid-to-late 1960s. About the same time, East Germany also clandestinely acquired an IBM computer and/or major subsystems and components which served as the basis for development of the ES-1040.

None of the other countries in Eastern Europe, so far as is known, has been directly involved in copying IBM computers or components.

The USSR copied mainly the architecture (organization)[10] of the IBM-360, while East Germany also appears to have attempted to copy the physical layout, subassemblies, and components. Copying by East Germany, which involved dismantling, measuring, and analysis of parts and circuitry, required at least 7,000 scientific-engineering man-years to bring the ES-1040 program to the stage of production prototypes.

East Germany may have chosen to go the route of complete duplication because of its willingness to use, or its broad access to, critical components from the West. The USSR, on the other hand, may have felt that it could leap-frog valuable development time by designing around its own components. In any event, East German copying efforts appear to have been the most successful, since its RYAD model ES-1040 more closely approximates the operational characteristics of the IBM machines than any other RYAD model.

The design of the Hungarian version of RYAD (ES-1010) is based on the design of a French computer which the French firm CII[11] in 1970 licensed Hungary to produce. Hungary modified the design of that computer to work with RYAD peripherals.

Since the USSR has been unable or unwilling to provide Eastern Europe with needed quantities or semiconductors, several countries have been forced to use Western-made semiconductors. For example, Hungary's model has been built with substantial reliance on Western components; Poland has acquired small quantities of Western semiconductors for RYAD development work; and East Germany has combined both Communist and Western (US, West German, and Japanese) components in its production models.

Soviet capability to provide components for RYADs—though severely limited—has been aided greatly by acquisition of Western-made machinery. The acquisitions have included whole plants for production of printed-circuit boards, machinery for most of the processes in IC manufacturing, specialized equipment for making memory cores, and technology for assembling and testing memories. The illegal acquisition of core presses and test machinery has made it possible for the USSR to provide increased memory capability in its new model RYADs developed after 1974.

Bulgaria may have received assistance in setting up production of disc drives and disc packs from West Germany in early 1972. Apparently, Bulgaria did not acquire technology for producing the critical magnetic recording heads, because Bulgaria purchased a large number of Western-made heads legally and illegally during 1972-74. Bulgaria also purchased a wide variety of machined metal parts for disc drives. East Germany is believed to have acquired significant assistance from West German firms for its RYAD development and production program, including production machinery and know-how.

Backwardness of Eastern Technology

The RYADs produced to date have failed to achieve the levels of technical performance specified by original design goals; speeds have been slower and memory capacities far smaller than desired. The USSR came closest to reaching original speed goals with the ES-1020, but still fell short by 15-25 percent. The Hungarian ES-1010s exhibited the poorest performance, with operating speeds falling short of goals by 30-50 percent. In all cases, RYADs were able to reach only about 25 percent of the original goals for memory capacity. Poor quality ICs and other design deficiencies were primarily responsible for failure to meet speed and memory goals. Table 3 compares the original design goals for speed and memory for four RYAD models with those actually achieved.

[10] A general application computer system consists of one or more processors, memories, input/output devices, and communications links. The number, interconnection scheme, and operating modes of these subsystems determine the architecture of the computer system.

[11] Compagnie Internationale pour L'Informatique.

Table 3

USSR and Eastern Europe:
Performance of RYAD Computers,
Planned and Actual

Thousand

Model	Speed (Operations/ Second)		Memory* (Characters)	
	Planned	Actual	Planned	Actual
1010	10	5-7	64	16
1020	20	15-17	256	64
1030	100	60-70	512	128
1040	380	250-300	1,024	256

* These are typical installed memory sizes; a few larger installations have been noted.

That the USSR is not reported to have delivered any RYADs with the maximum internal storage capacity cited in early design goals may be due in part to manufacturing problems that forced use of cores with 0.8-mm outside diameter rather than the 0.6-mm cores originally specified for the computers. The larger power requirements and increased heat dissipation problems with the larger cores impose constraints on the capacity and performance of the internal memories that are physically and economically practical for most RYAD installations.

Medium-sized RYAD systems (ES-1020s and ES-1030s) have a poor record for reliability. Central processors currently appear to operate satisfactorily, but users continue to complain of lengthy downtime from overheating of components and frequent breakdowns of peripherals. Poorly constructed magnetic disc drives suffer from dust contamination and metal expansion from temperature changes; these drives require excessive downtime for scheduled maintenance alone. In contrast, the East German model ES-1040, which has been examined by a US computer manufacturer, is said to be highly reliable in operation.

The Soviets continue to grapple with the technological design of the most powerful RYADs, the ES-1050 and ES-1060. To achieve the high speeds called for in these models, the designers are using special ECL (emitter coupled logic) integrated circuits. These circuits tend to break down under conditions of high heat generated by their large power requirements and sustained by the poor heat dissipation characteristics of the computer's design. Recently, some ES-1050s have been delivered to Soviet users although series production is not yet apparent. The ES-1060 continues to be under development.

Troubles with Software

Users of RYADs are faced with exceptional difficulties in meeting data processing needs with existing software.[12] Few standard applications programs have been developed from scratch for use with RYAD. For the most part, programs currently in use were originally developed with the MINSK-32 and have been rewritten to operate with RYAD. Even so, delays have been extensive; the complexities of software alteration have left many of the MINSK-32 programs, as well as programs developed for other Soviet computer models, still not converted for use with RYAD. In addition, users have been unable to use, without modification, the inventory of software programs devised by IBM for use with its Series-360 machines because: (a) many IBM programs were designed for use in a different institutional environment and simply are not applicable; (b) the memory capacity (especially external random access disc storage) requirements of many IBM programs exceed the capabilities of RYAD computers; and (c) since the operating system for the Soviet RYAD is not a precise duplicate of the IBM-360, most IBM programs require modification to run on RYAD machines.

[12] Software is of two types: (1) *Systems* software, which refers to the sets of instructions needed to operate a computer; and (2) *Applications* software which refers to the programs written for use with the computer facilities of a given industrial plant, laboratory, or military installation. Programs are written for use with a particular computer installation and can be run on a different installation only if they, or the installation, are modified.

As an exception to these limitations, users of the East German ES-1040s may be able to employ directly IBM-360 applications programs. East Germany seems to have duplicated the IBM operating system successfully. East Germany's assimilation of IBM design—a sharp contrast with the experience of other RYAD producers—probably reflects the closeness of its cooperation in computer technology with West German manufacturers.

The Soviets have intensified efforts to rewrite existing RYAD programs and to develop new standardized data processing programs specifically for RYAD computers. At the same time, the Soviets are developing new operating systems to reduce the need for program modifications. For example, the development of DOS-2 (Disc Operating System), which is capable of utilizing "most" of the programs for the MINSK-32, was recently announced. This system may be intended for use only with the RYADs produced at Minsk, since it was developed at the Minsk Scientific Research Institute of Electronic Computers, the institute that designed the ES-1020 and ES-1022. A larger and much more versatile system, called ES-0S, also is under development. It is being designed to execute several different programs simultaneously (multiprograming).

The status of DOS-2 and ES-0S in mid-1977 is not known. The OS, in particular, has not been fully tested; implementation of this operating system will require internal and external memory capacity greater than what is being delivered with most RYADs. Checkout and debugging of ES-OS almost certainly will continue for several years.

Acceptance of RYADs

The USSR is the largest user of RYADs. During the Ninth Five-Year Plan, East Germany shipped about one-third of its output to the USSR, and Hungary about 80 percent of its output. Czechoslovakia and Bulgaria produced RYADs mainly for their domestic markets. Of the more than 200 RYADS exported since 1972 by the USSR, the bulk of these were supplied to Eastern Europe. The USSR has shipped RYADs to the Netherlands, Belgium, and Finland for use in Soviet-controlled firms in those countries, to India, and probably to a few other non-Communist countries. According to a high-ranking official of the Soviet computer industry, Soviet-controlled firms will attempt to market more than 500 RYADs, apparently in Western Europe, during 1976-80. RYADs may eventually find a small market in developing countries if reliability, servicing, and the availability of spare parts can be improved.

Czechoslovakia, Hungary, and Poland have participated in the RYAD program reluctantly. Understandably they prefer native or Western computers for their own use. Poland, in particular, favors its own successful line of ODRA computers, which have been built under British license. However, Soviet pressure is mounting for greater participation by Poland in the RYAD program, lessening Poland's chances to market ODRAs in Eastern Europe as an alternative to RYAD.

RYAD in Transition

Even as RYADs began to go into large-scale production in 1974, the Soviets were busy designing more powerful versions of the basic models. These new computers, the ES-1022 and ES-1033, are to replace the ES-1020 and ES-1030. They have been designed to operate much faster than the original models—five times as fast in the case of the ES-1022—and to have double the memory capacity (see table 3). Higher speeds and larger memories are achieved through the application of more powerful circuits and smaller memory cores; otherwise, the original models are largely unchanged.

The new models went into production in the USSR in 1976 and production of the original models has been substantially reduced. Production rates of the new machines can be expected to rise rapidly since no major changes in manufacturing technology need to be assimilated. Indeed, in the case of the ES-1022, recently introduced simplified production methods may enhance learning effects. Even so, in 1976 and

Table 4

Estimated Characteristics of the Modified RYAD Computers

Model	Speed (Operations/ Second)	Memory (Thousand Characters)
ES-1012	10	64
ES-1022	100	512
ES-1032	200	1,024
ES-1033	150-200	1,024
ES-1050	500	1,024

1977 at least, total production may not reach the maximum level achieved for the original RYADs in 1975 for a variety of reasons. The changeover involves disruption to the rhythm of production; dissatisfied users of ES-1020s are shipping their machines back to the factory for conversion into 1022s; and shortages have already surfaced in the supply of higher powered integrated circuits.

In Eastern Europe, only Hungary and Poland have introduced upgraded models in the first series of RYAD machines. In 1973, Hungary introduced an upgraded ES-1010, called the ES-1010BM. Further modifications such as the ES-1012 will not be able to run RYAD applications programs, as was the case with the ES-1010.

Poland has developed the ES-1032, a model that has operating speeds comparable with those of the Soviet ES-1033. It appears to have been developed independently of the USSR. Acceptance testing was under way in mid-1976 and the model may now be in production. Poland claims to have the capacity to produce "many more" than 25 units annually and will produce the ES-1032 on a special order basis.

In addition to the computer proper, the USSR is attempting to improve the capabilities and diversity of peripheral devices for use with RYADs. In 1974, the Soviets claimed to have developed 33 new peripherals, including relatively advanced types with advertised specifications close to those in use in the West a few years ago. A few of these—for example, graphic terminals, data transmission equipment, plotters—have been shown at trade fairs, usually in a nonoperating mode; none of the advanced devices have been observed in use with RYAD in a user environment. Indeed, RYAD computers are still being delivered with the standard configurations of the peripherals offered five years ago; in many cases, these peripherals are simply repackaged versions of devices developed for even earlier computers. Thus, significant new peripherals apparently are not yet being produced, at least in quantity.

Some progress has been made by Bulgaria in mastering the technology for manufacturing high-capacity magnetic disc devices, which are needed to exploit fully the inherent processing capabilities of the new models. In late 1976, US visitors to the East German plant that produces ES-1040 observed a large number of Bulgarian-made 30-megabyte drives. The East Germans allege that the drives operate reliably. The US visitors were not allowed to inspect the drives to determine if the components (especially the magnetic recording heads) were of Communist or Western origin.

For its part, the USSR also claims to be producing 30-megabyte drives—some have been displayed at trade fairs—but these claims are doubtful. The Soviets are still attempting to acquire US technology to make such drives, and the Ministry of the Radio Industry reportedly has been experiencing technical difficulties with production.

Prospects for a RYAD II Generation

In October 1974, the RYAD partners announced that a new generation of RYAD computers, called RYAD II, was under development, but a target date for production has not been announced. RYAD IIs, patterned after the current IBM Series 370 computers, are to be much more powerful than current models and to represent a major advance in Communist computer technology. They are to be compatible with existing RYADs and with both IBM-360

and IBM-370 machines. According to Communist sources, RYAD IIs will have:

- A much larger capacity for internal storage of data. This will be accomplished, in part, through the use of semiconductor memories and, in part, through the use of "virtual" memory.[13]
- A larger number of data channels and high-speed multiplexers.[14] These features will permit the use of higher speed peripherals and greatly increase data processing capabilities.
- A capability for "network" operations, that is, for computer-to-computer communications.
- Improved reliability through computer self-diagnosis of faults.

The technology of RYAD II is far beyond current state of the art in the USSR and Eastern Europe. In particular, RYAD II will need very high density integrated circuits (large-scale integration–LSI) for internal memory and some logic processes. Circuits currently in use are relatively simple, low-density (small-scale integration–SSI) types. The capacity of the disc drives needed (100 megabytes and larger) exceeds the capacity of drives available from Bulgaria by more than three times and of drives most commonly in use by almost 15 times. The complexity of the software needed to operate RYAD IIs is considerably greater than that now in use.

The Soviets claim to have developed working prototypes of two models of RYAD II, the ES-1035 and the ES-1060,[15] and to be nearing production of these two models. The USSR conceivably could produce a small number of these models during the 10th Five-Year Plan; because of the enormous leap in technology required, however, any units produced would have few of the advanced features indicated above. In particular, "network" operations are doubtful for many years because of the lack of data transmission equipment.

If RYAD IIs are to be produced according to design specifications before 1980, a great deal of Western machinery and production know-how will be required. Indeed, the vigor with which the Soviets seek this technology, by both legal and illegal means, will provide an indication of the priority attached to this program.

Economic Implications

In the near future the number of RYADs in operation will be too small to give a noticeable boost to the Soviet economy. By 1980, 5,000 RYADs may be installed and at work in the USSR. No more than half are likely to be in production facilities–as opposed to institutes and universities–and many of the larger plants will have more than one. Of the roughly 50,000 industrial enterprises, fewer than 5 percent will be equipped with RYADs by 1980–that is, with a modern data processing capability.

RYADs in place will continue to be used unproductively by US standards. Soviet computers are operated 11 to 12 hours a day, whereas 16 to 18 hours or more are considered necessary for economic use in Western economies. The almost desperate shortage of qualified personnel is another factor impeding effective utilization. The planned replacement of existing MINSK-32s with RYADs adds another costly and disruptive element; as noted previously, complex modifications of MINSK-32 programs are needed before this software can be used on RYADs.

Higher echelon organizations, at the ministry or national level, will be especially hard put to carry out complex planning and management activities with RYADs, since only the smaller machines will be generally available; development of required software will require huge investments of technical resources. Moreover, the collection and processing of data from subordinate echelons will be difficult and inefficient since data transmission facilities for computer-

[13] A technique for increasing the apparent internal storage of a computer by special programs that allow disc storage to act as internal memory.

[14] Channels are provisions for external access to the computer; multiplexers are devices that permit more than one external device to be connected to the computer via a single channel.

[15] This model is assumed to be a redesign of the ES-1060 of the original RYAD series that was never produced.

to-computer communications will not be available.

The increasing availability of RYAD computers in plants, institutes, and other organizations should result in some reduction of the share of manpower assigned to clerical work. It is not clear, however, that they will provide a net labor savings for industry or the economy as a whole. Users need to acquire personnel and staff to service and maintain the computers; the Soviets have found that it takes 150 to 200 percent more people, on the average, to operate a computer than it does in the West. In addition, computer people command higher wages than the people they are replacing.

Military Implications

The Soviets have traditionally used special purpose computers for military systems with specific functions, such as missile guidance or airborne navigation. These special purpose computers probably will continue to enjoy a high priority in the Soviet computer industry. In addition, the USSR needs general purpose computers with good data handling capabilities for a large variety of military activities, such as R&D, control and monitoring of space activities, command and control, and logistics. Nonmilitary computers, such as BESM-6s and M-222s, have always been used for these purposes. RYADs, especially the newer models now in production, will provide improved data-handling capabilities over these models.

Currently, there is limited use of RYADs in Soviet military plants and institutes. Their employment for the broader military problems listed above will have to await full development of larger RYAD systems, including especially major improvements in disc storage capacity and software, maintenance, and user experience. Use of RYADs for these complex military purposes cannot be expected before the 1980s.

Perspective

Since World War II, the Soviet economy has expanded more through extensive growth (the channeling of larger and larger amounts of labor and capital into production) than through intensive growth (the achievement of higher and higher yields from each unit of labor and capital). Experiences in the computer field illustrate this general economic pattern. The modernization of the Soviet computer industry has been given high priority by the central leadership, and planners have provided increasing inputs of factory floorspace, technical labor, and funds to purchase foreign technology. At the same time, difficulties and delays common to the whole economy have appeared, such as (a) setbacks in production schedules, (b) shortages of peripheral equipment and support services (support services tend to be neglected under central planning), and (c) reluctance of potential users to accept the disruptions that accompany a transition to new equipment or to new models of old equipment. Use of the computer tends to underscore the worst features of the Soviet economy. Thus, while the USSR is gradually incorporating the fruits of the computer revolution into its economy, its mastery of the computer is approximately 10 years behind the West.

The author of this paper is [redacted] 25X1A
USSR/Eastern Europe Division, Office of Economic Research. Comments and queries are welcome and should be directed to Mr. [redacted] *telephone 351-6716.* 25X1A

APPENDIX

Methodology For Production Estimates

Unit Production

Little hard information is available on which to base estimates of RYAD production in 1971-75. The numbers in table 1 in the text have been put together from a variety of sources, including: (a) open source information; [redacted] (c) reports of emigres; (d) observations by Western visitors to Eastern computer plants; and (e) other, [redacted] The numbers are estimated through 1974 with high confidence. The 1975 estimates, especially for the USSR, are more tenuous.

25X1B

25X1B

25X1B [redacted] visits by US personnel to the Minsk Plant allowed an estimate to be made through 1973 for the ES-1020 and through 1974 for the ES-1030.

In 1974, several US visitors to the Minsk Computer Plant observed production of the ES-1020 and made some estimates of the capacity of the plant. They observed that the plant was producing at a capacity of 400-500 computers annually, and that twice as many ES-1020s as MINSK-32s were being produced (300 ES-1020s and 150 MINSK-32s). For 1975 the capacity remains the same, but it is known that MINSK-32 production was being phased out. Production of the ES-1030 for 1974 represents a reasonable production of the series from the previous years.

Total production of the East German ES-1040 for 1971-75 was given to various US personnel on several occasions and was confirmed by random

25X1B [redacted] The annual series represents a logical allocation of this total. Total RYAD production for the period in Bulgaria, Czechoslovakia, Hungary, and Poland is provided [redacted] 25X1C and, in the case of Hungary, by open sources. The annual figures are distributed on the basis of fragmentary information.

Ruble Production: USSR

Table 2 provides an estimate of the production value of Soviet RYAD computers as a percentage of the total value of Soviet computer production. The latter series is from official Soviet statistics, whereas the RYAD value series is based on the unit estimates in table 1 and published prices of 525,000 rubles for the ES-1020 and 920,000 rubles for the ES-1030.

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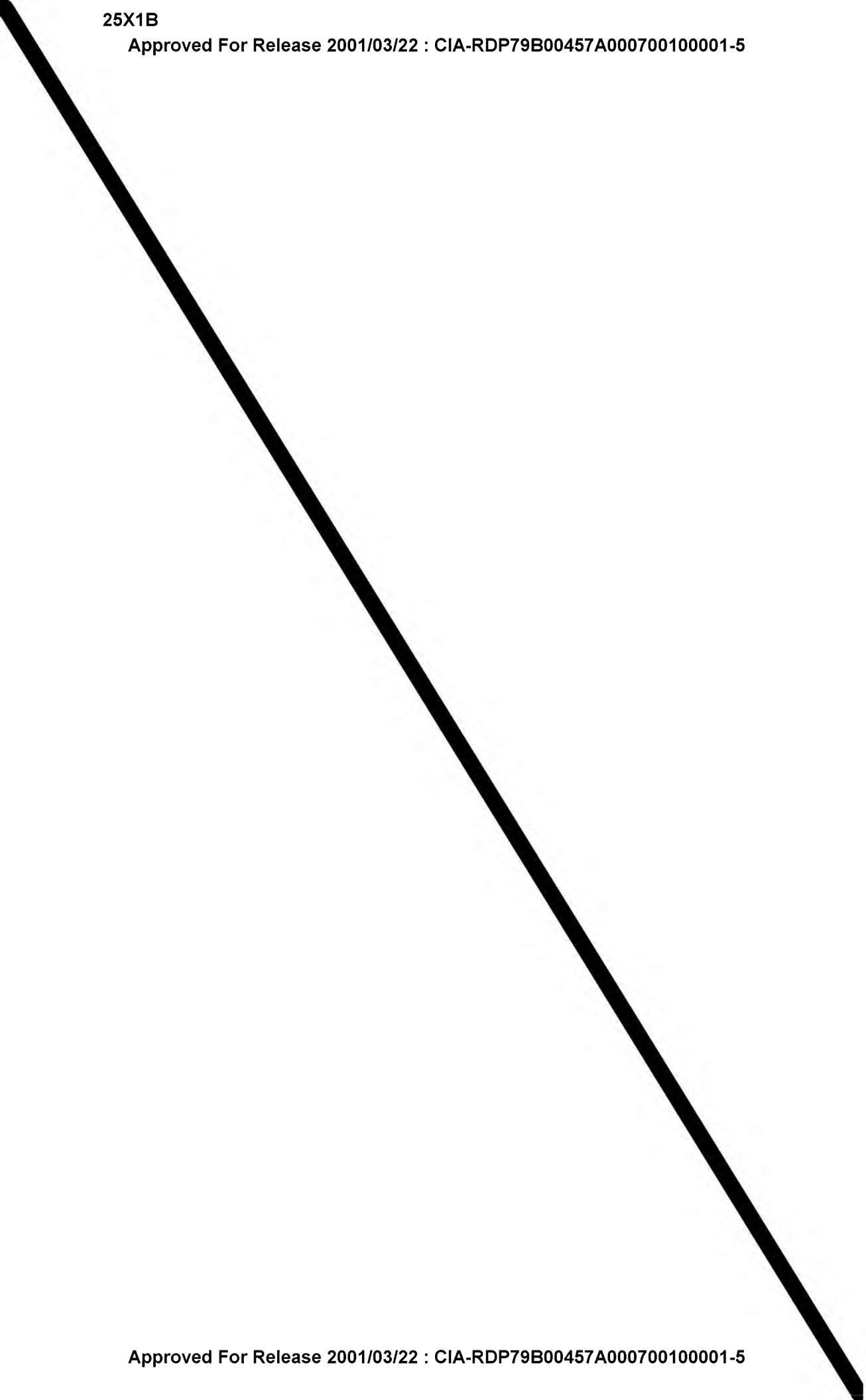

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